

# Emotion Effects on the Neural Basis of Decision-making in the Ultimatum Game

Johannes Hewig<sup>1</sup>, John J.B. Allen<sup>2</sup>, Carolin Richter<sup>3</sup>, Holger Hecht<sup>3</sup> & Wolfgang H.R. Miltner<sup>3</sup>  
<sup>1</sup>Julius-Maximilians-Universität Würzburg, Germany; <sup>2</sup>University of Arizona, Tucson, Arizona, USA; <sup>3</sup>Friedrich-Schiller-University Jena, Germany

## Introduction

Recently the neural basis of decision-making in economic games like the Ultimatum game has received broad interest (e.g. Sanfey et al. 2003<sup>1</sup>, Hewig et al. 2011<sup>2</sup>, Weiland et al. 2012<sup>3</sup>). In the Ultimatum game a proposer divides an amount of money and the outcome of the division depends upon the decision of a receiver. Neural activity in cingulate cortex has been reported for both proposers and receivers. In addition, the influence of emotions upon decisions in these games has been examined in detail in behavioral studies (e.g. Harlé et al. 2010<sup>4</sup>). In the present study we investigated the neural basis of affective influences on decision-making in the Ultimatum Game.

## Method

Participants were receivers in the Ultimatum Game and completed 10 blocks of 30 trials with offers ranging from 6:6 to 11:1 in a 3 Tesla scanner. Before each block participants viewed a film clip. For each of the five emotion conditions (neutral, happy, fear, sadness, and anger), two experimental blocks were each preceded by a short film clip. In each trial during a block, a picture from the film was presented briefly (Figure 1). The neural activity in response to fair and unfair offers and dependent upon the decision to accept or reject the offer was analyzed for each of the five emotion conditions.

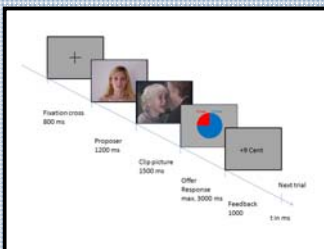


Figure 1. Design of a trial

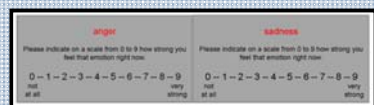


Figure 2. Rating Scale after blocks

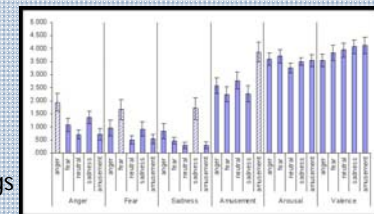


Figure 3. Subjective Ratings

## Behavioral Results

Our statistical analyses supported the notion that behavioral effects were related to the affective valence of the clips. Negative emotions increased rejection rate whereas happiness decreased it for mildly unfair offers (see below left panel,  $p < .05$ ). The effects were amplified by subjective ratings of arousal - being stronger in high arousal participants. However, for extremely unfair offers both positive and negative emotions increased rejection rate. Subsequent, exploratory analyses of each emotion showed the effects were mainly due to anger, fear, and happiness (see below right panel).

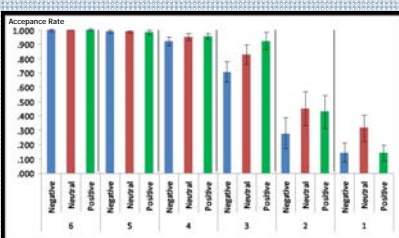


Figure 4. Acceptance for high arousal subjects for each offer and film valence

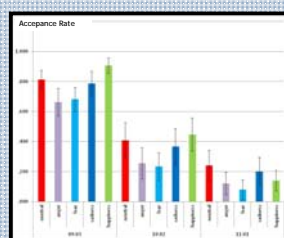
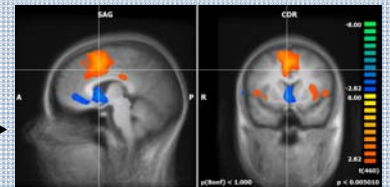


Figure 5. Acceptance for high arousal subjects for unfair offers and film emotion

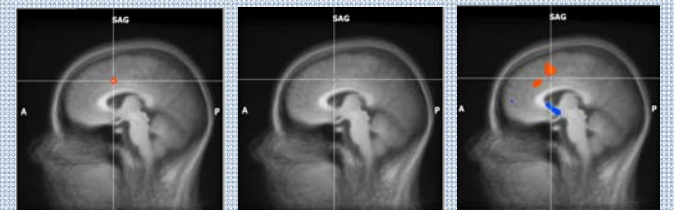
## fMRI effects

Unfair offers (vs. fair) were related to increased activity in dorsal anterior cingulate cortex as in previous Studies ( $p = .005$  in all analyses).

Figure 6. 11:1 offers vs 6:6 offers:



Emotion induction modulated the latter activity in dorsal anterior cingulate cortex (ACC) under anger (left) and happiness (right) as compared to neutral (middle) and activated further regions related to affective processing. Figure 7. 11:1 offers vs 6:6 offers for the three conditions.



Further analyses aimed to reveal the neural basis of the behavioral effects of the emotion induction that were particularly strong in high arousal subjects. 1) For extremely unfair offers (11:1) under happiness vs. neutral ACC and Insula showed increased activity (Figure 8). 2) For all unfair offers (9:3, 10:2, and 11:1) under negative emotion induction as compared to neutral Insula was activated as well, indicating that Insula might detect autonomic arousal in the latter conditions and may be involved in biasing decision-making (Figure 9).

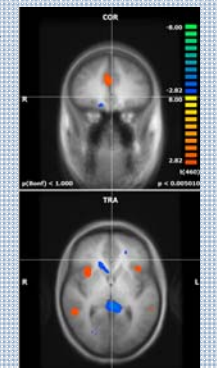
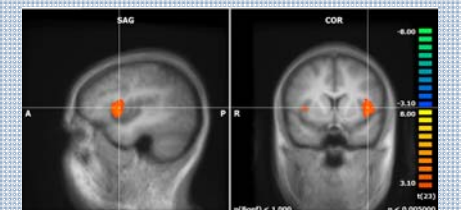


Figure 8.



3) Mildly unfair offers (9:3) under happiness vs neutral showed reduced activity in Precuneus (Figure 10).

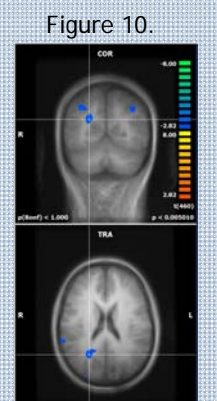


Figure 10.

## Conclusion

The present results are in line with previous findings on the neural basis of decision-making. Furthermore, we present a first dataset on the neural basis of the influence of emotion on decision-making in the Ultimatum game indicating the importance of the ACC and the insula.

mailto:hewig@psychologie.uni-wuerzburg.de

Refs: 1Sanfey A. G., Rilling J. K., Aranson J. R., Nystrom, L. E., & Cohen, J. D. (2003). The neural basis of economic decision-making in the Ultimatum Game. *Science*, 300(5626), 1755-1758.  
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